Center Innovation Fund: JSC CIF

Laser Processed Heat Exchangers

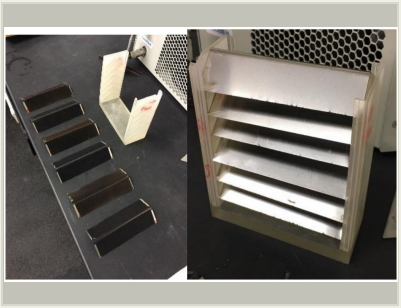
Completed Technology Project (2016 - 2017)

Project Introduction

The considerable mass of Heat Exchangers (HXs) and coldplates on spacecraft as well as the problematic coatings of the Condensing Heat Exchanger (CHX) are among the significant technical issues to be solved before long-duration spaceflight can occur. Specifically, high reliability CHX's and reduced mass HXs and coldplates have been identified by the Evolvable Mars Campaign (EMC) as critical technologies needed to move beyond low earth orbit. The Laser Processed Heat Exchanger project aims to solve these problems. It will investigate the use of femtosecond laser processed surfaces to replace the harmful and problematic coatings of current CHX's and to reduce mass and volume in liquid/liquid heat exchangers. For this project, two sub-scale HX's will be designed, manufactured, and tested. These two units consists of a high reliability CHX and a high efficiency liquid/liquid HX. The goal of the high reliability CHX is to eliminate the dependency upon coatings and prove the feasibility in manufacturing a hydrophobic laser patterned CHX. Additionally, microbial growth testing will be conducted on the unit to assess its potential as a microbial growth mitigation strategy. The goal of the liquid/liquid HX is to increase heat transfer by 25% compared to an identical non-treated HX, directly translating to reduced mass and volume. To accomplish development of a high reliability CHX and decreased mass and volume HXs, this project will be using femtosecond laser processed surfaces ("functionalized surfaces") to create a unique hydrophobic condensing surface for the CHX. A hydrophobic CHX will be designed and constructed. Testing of the CHX will take place in an airstream to validate construction methods, performance, and microbial growth resistance. Additionally, the project will be using functionalized surfaces to create increased heat transfer in a liquid/liquid HX via increased surface area and low interfacial thermal resistance. Testing for increased heat transfer will be completed through design and development of a functionalized HX and a typical stainless steel HX.

Anticipated Benefits

Liquid/liquid and air/liquid heat exchangers (HXs) are essential components for manned spacecraft. However, these HXs typically have high mass and volume requirements. In addition, state-of-the-art condensing heat exchanger (CHX) technology utilizes chemical coatings which slough off over time and react with contaminants in the air to form Dimethylsilanediol (DMSD) and related compounds, ultimately reducing the lifespan of the multifiltration Beds. This project seeks to use functionalized surfaces to develop a high reliability CHX which does not rely on coatings that slough off over time, does not create harmful by-products, and is microbial growth resistant. Furthermore, functionalized surfaces will be used to develop a low mass and volume liquid/liquid HX.



a) Laser processed louvers b) non-processed lovers in louver holder.

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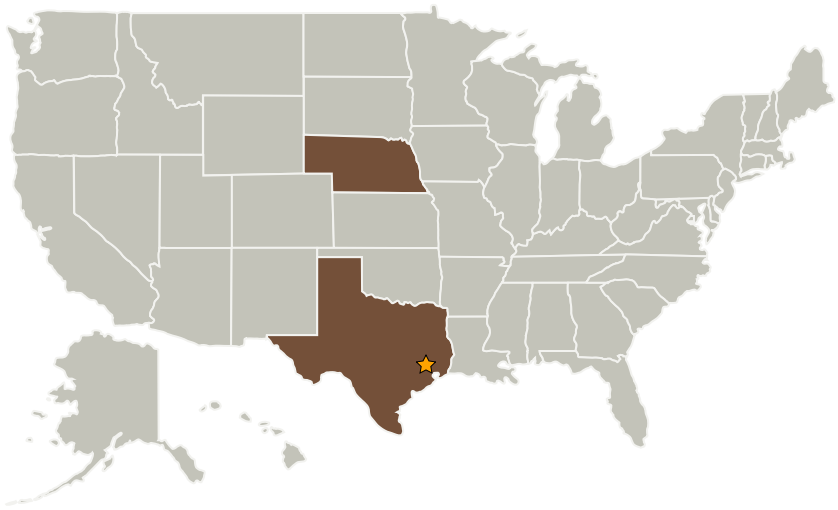
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas

Primary U.S. Work Locations	
Nebraska	Texas

Project Transitions

October 2016: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Center Innovation Fund: JSC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

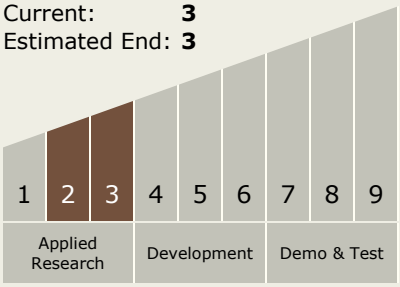
Carlos H Westhelle

Principal Investigator:

Scott W Hansen

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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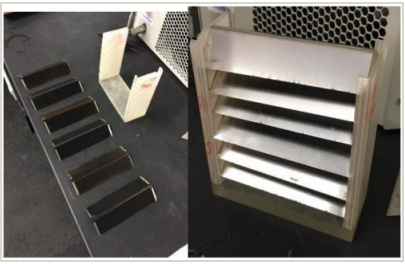
July 2017: Closed out

Closeout Summary: The proposed technology utilizes femtosecond laser processed surfaces to reduce mass and volume in liquid/liquid Heat Exchangers (HXs) and seeks to replace the harmful and problematic coatings of current Condensing Heat Exchanger (CHX) technologies. This project leverages the use of femtosecond laser processing in two types of HXs. First, for liquid/liquid HX's, laser processing may increase overall heat transfer through creation of "nanofins" and decreased interfacial thermal resistance of the nanofins. This could lead to smaller, reduced mass HXs. Second, for CHX's, laser processing on a silver substrate creates a naturally hydrophobic surface. This surface exhibits antimicrobial properties which must be utilized in a future CHX for exploration. Additionally, because the surface does not rely on a chemical coating, potential for catalysis with environmental contaminants are limited.This technology could provide benefits to applications requiring antimicrobial properties (medical applications & surgical implants).

Images



Project Image
a) Laser processed louvers b) non-processed lovers in louver holder.
(https://techport.nasa.gov/image/35777)

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.2 Thermal Control Components and Systems
    - TX14.2.1 Heat Acquisition

Target Destinations

Earth, The Moon, Mars